# Intelligent Control Systems for Manufacturing

*An intelligent controller—working with "smart" sensors and "smart" actuators—will lead to more accurate products and higher reliability on the production line.*

For U.S. industry, one technical leap forward will be the use of intelligent control systems that integrate continuous streams of information for fine-tuning or modifying the manufacturing process. At Lawrence Livermore National Laboratory, we are playing a crucial role in the development of such systems.

The benefit to industry will be leaner, more flexible operations that manufacture more accurate products with less downtime and waste. Intelligent controllers will also pave the way for "agile manufacturing," enabling an operation to be rapidly reconfigured for different products.

An intelligent control system includes (1) smart sensors that continually measure various parameters (such as product temperature or composition of raw materials), (2) a "mastermind" controller that interprets this flow of data via product / process models and algorithms and communicates instructions to (3) the smart actuators that instigate actions (such as adjusting valves or compensating for temperature changes) and in turn send information back to the controller. We are defining and developing an Open Modular Architecture Controller (OMAC) to serve as the mastermind and to interface with the sensors and actuators.

One of our goals is to incorporate "plug and play" modules into the controller as needed for greater flexibility. Another goal is to tap the full richness—rather than just portions—of the product model as designed. Finally, we hope to develop a controller with sufficient intelligence to "learn" from the interactive flow of information and then to continuously improve the product / process models it uses.

## Defining the Controller Architecture

Our focus on intelligent controllers for the shop floor intensified several years ago through participation in the U.S. Department of Energy's Technologies Enabling Agile Manufacturing Program, an industry / government alliance to deploy technologies for agile manufacturing. To this effort, we brought LLNL's long-standing experience in precision engineering and controller development for national defense purposes.

As part of the TEAM effort, we defined what the controller architecture should be, developed the underlying real-time application software, and developed a prototype controller for a milling machine. The objective was to develop a generic controller that could be adapted to various types of machine tools and that would enable those machine tools to be quickly reconfigured for producing different parts.

## Industry's OMAC Users Group

The controller architecture we developed through TEAM has now been adopted by the Open Modular Architecture Controls (OMAC) Users Group, which encompasses a wide range of U.S. companies and technology organizations (including LLNL). The purpose is to accelerate and standardize the development of open architecture control technology and to facilitate its adoption by industry.

## Totally Integrated Munitions Enterprise (TIME)

We are now working on the Totally Integrated Munitions Enterprise project to test information-based manufacturing technologies in the U.S. Army's

### Industry Applications

***Discrete parts***

- Munitions
- Automotive
- Aircraft
- Engines

***Continuous Process***

- Chemicals
- Pharmaceuticals
- Forest products

munitions manufacturing complex. For the Army, we are completing the development of an intelligent controller for milling machines.

The controller we are developing will help the Army broaden its base of industrial suppliers because manufacturers will be able to quickly adapt to munitions production on an as-needed basis. The increased flexibility and on-demand capability will also let the Army more readily adopt newer munitions technologies, rather than having to rely on older stockpiled products.

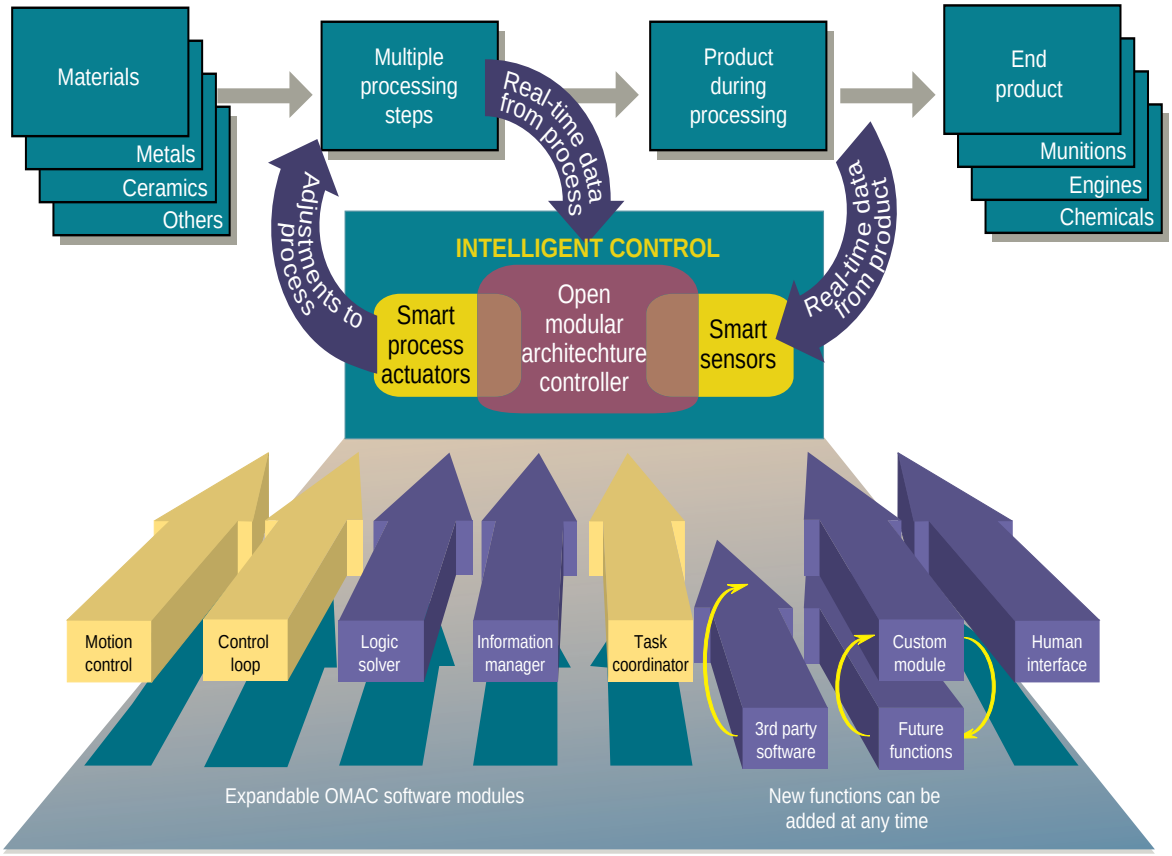
We have developed a prototype controller that conforms to the OMAC requirements. The system currently operates a three-axis mill using a standard personal computer with no proprietary hardware and running Windows 95.

## Future Applications

Intelligent control systems can be developed for both discrete part and continuous process production lines—and for various types of production modes, such as milling, lathing, or extruding.

At LLNL, we want to work with companies interested in bringing the benefits of intelligent controls into their manufacturing enterprise.

Contact: Bob Burleson
Lawrence Livermore National Laboratory
P.O. Box 808, L-644
Livermore, CA 94551
Phone: (925) 423-1967
Fax: (925) 423-7914
email: burleson1@llnl.gov




An intelligent controller continually evaluates data from the product being processed to fine-tune the manufacturing line for a more reliable end product.

UCRL-MI-132860 January 1999
Work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract W-7405-ENG-48